

The effect of chronic carbon-monoxide exposure on the peak expiratory flow values of grill-kebab chefs

Behcet Al, MD, Cuma Yildirim, MD, Suat Zengin, MD, Murat Cavdar, MD, Ismail Togun, MD.

ABSTRACT

الأهداف: تحديد أثر التعرض المزمن لأكسيد الكربون الأحادي (CO) على قيم هيموجلوبين-كاربوكسي الدم (COHb) في حالة حدوث انسداد في مخرج الهواء أو عدم حدوثه لدى طبّاخي الكباب المشوي.

الطريقة: أجريت هذه الدراسة بكلية الطب – مستشفى ساهينبي بجامعة جازيانتيب – تركيا، خلال الفترة ما بين مارس 2007م حتى نوفمبر 2007م. تم جمع 40 رجل يعملون طبّاخين للكيباب المشوي، والذين يعملون لدى مطاعم لمدة ثلاث سنوات، وعدد 48 رجل متطوع غير مدخن سليم لهذه الدراسة. تم قياس العمر، مدخلات كتلة الجسم (BMI)، ضغط الدم (BP)، هيموجلوبين كاربوكسي الدم (NT-proBNP)، وقيم ذروة تيار التنفس (PEF) لطباخي الكباب المشوي ومجموعة التحكم. تم إجراء التحليل الإحصائي بواسطة استعمال برامج التحليل الإحصائي 13.0 (SSPS).

النتائج: كان متوسط العمر لمجموعة الدراسة ومجموعة التحكم 33.0 ± 9.1 و 34.7 ± 6.5 عام على التوالي. بلغ متوسط وقت العمل لمجموعة الدراسة 33.0 ± 9.1 و 34.7 ± 6.5 عاماً على التوالي. بلغ متوسط الانشغال لمجموعة الدراسة 16.1 ± 7.3 عاماً. تبدو السمات السريرية، العمر، مدخلات كتلة الجسم (BMI) وقيم (NT-proBNP) للمجموعتين متشابهة. كانت قيم (COHb) ($6.5 \pm 1.5 / 2.0 \pm 1.1$) أعلى عند طبّاخي الكباب المشوي وفقاً إلى مجموعة التحكم. تم تحديد قيم (NT-proBNP) في إطار طبيعي ($< 60 \mu\text{g/L}$). تم تحديد انخفاض سرعة (PEF) (متوسط: $65.1 / 7.1$ لتر/دقيقة) على أنه أعلى لدى مجموعة طبّاخي الكباب المشوي من مجموعة التحكم.

خاتمة: التعرض المزمن لأول أكسيد الكربون (CO) يسبب انخفاض (PEF) عن طريق تضيق مخرج الهواء لدى طبّاخي الكباب المشوي.

Objectives: To determine the effect of chronic carbon-monoxide (CO) exposure on blood carboxy-hemoglobin (COHb) values in grill-kebab chefs, and if there is any subsequent airway obstruction.

Methods: The study was carried out in Sahinbey Hospital, Medical School of Gaziantep University, Gaziantep, Turkey, between March 2007 and November 2007. Forty male grill-kebab chefs, working in restaurants for at least 3 years, and 48 non-smoker, male healthy volunteers were gathered for this study. The ages, body mass indexes (BMI), blood pressure (BP), COHb, N-terminal pro brain natriuretic peptide (NT-proBNP), and peak expiratory flow (PEF) values of the grill-kebab chefs and controls was measured. Statistical analysis was carried out using the SSPS 13.0 software.

Results: The average age for the study group was 33.0 ± 9.1 , and for the control group was 34.7 ± 6.5 years. The average occupation time for the study group was 16.1 ± 7.3 years. The clinical attributes, ages, BMI, BP, and NT-proBNP values of both groups were similar. The COHb ($6.5 \pm 1.5 / 2.0 \pm 1.1\%$) values were higher in grill-kebab chefs compared with the control group. The NT-proBNP values were determined as normal ($< 60 \mu\text{g/L}$) in both groups. A higher decrease in PEF speed (average: $65.1 / 7.1$ L/min) was recorded in the grill-kebab chefs.

Conclusion: Chronic exposure to CO decreases PEF, with narrowing of the airway in grill-kebab chefs.

Saudi Med J 2009; Vol. 30 (6): 788-792

From the Department of Emergency (Al, Yildirim, Cavdar), Faculty of Medicine, University of Gaziantep, Gaziantep, the Department of Emergency (Zengin), Malataya State Hospital, Malatya, and the Department of Emergency, (Togun), Avukat Cengiz Gokcek State Hospital, Gaziantep, Turkey.

Received 18th February 2009. Accepted 3rd May 2009.

Address correspondence and reprint request to: Dr. Behcet Al, Department of Emergency, Faculty of Medicine, University of Gaziantep, Gaziantep, Turkey. Tel. +90 (342) 3606060. Fax. +90 (342) 3602839. E-mail: behcet.al@gmail.com

Carbon monoxide (CO) is a colorless, odorless, tasteless, non-irritating gas, which occurs due to incomplete burning of carbon containing materials, and can easily be absorbed by the lungs. Acute CO

intoxication is among the leading intoxications resulting in death due to its early and late stage effects.¹ The CO, which creates carboxy-hemoglobin (COHb) by connecting to hemoglobin, may cause several clinical problems from specific appearances to coma leading to hypoxia in several organs, starting with the myocardium.² Chronically, CO intoxication usually occurs in people who are in long term contact with CO due to their profession. The exact diagnosis of intoxication is possible by determination of high COHb levels.^{3,4} While there is much information on the effects of acute CO intoxication on the human body, our information on the effects of chronic CO exposure on the respiratory system, cardiovascular system, and atherosclerosis is limited, and data resulting from human and animal tests do not correspond.⁵ Natriuretic peptides are a hormone family that regulates blood pressure, electrolyte balance, and liquid volume.⁶ They are especially important in the diagnosis of heart insufficiency (HI), determination of the treatment strategy, evaluation of the treatment response, and tracking of mortality and morbidity.^{7,8} In the case of ventricular widening and increase of pressure, the physiological active hormone, brain natriuretic peptide (BNP), and the inactive metabolite N-terminal pro brain natriuretic peptide (NT-proBNP) are synthesized. The NT-proBNP is an important parameter, especially in determining the existence of left ventricular dysfunction.^{9,10} Peak expiratory flow (PEF) is the maximum expiratory flow speed due to a forced expiration after a forced inspiration. The PEF measurement is defined as liters per minute, and is used for measuring the range of great airway obstructions. Values were determined according to height and age by Gregg and Nunn¹¹ using the data collected from previous studies. Over the following years, the normal limits for healthy males and females between 15-85 ages were revised again by the same team from the results of new studies.¹² It is known that air pollution, smoking, and being exposed to gases that cause airway inflammation decrease PEF values.¹² Being chronically exposed to CO at moderate levels without acute intoxication is especially observed in barbecue workers (grill-kebab chefs), machine operators, firemen, and mine workers, who do not have enough air circulation in their working environment. Our purpose in this study was to investigate COHb values in grill-kebab chefs, and to determine the occurrence of airway obstruction after chronic CO exposure.

Methods. This study was conducted in Sahinbey Hospital, Medicine School of Gaziantep University, Gaziantep, Turkey, between March 2007 and November 2007. The protocol was conducted in accordance with the Helsinki Declaration and approved by the Scientific

Ethics administrative board. Forty male grill-kebab chefs working in restaurants for at least 3 years, and 48 non-smoker (smoking status was evaluated by self-report) healthy male volunteers were gathered for this study. For the study group, all the participants were recruited from different kebab restaurants where they cook kebabs on the grill for at least 48 hours per week. For the control group, the volunteers were collected from our hospital personnel (16 technicians, 19 doctors, 4 ambulance drivers, and 9 security guards). Exclusion criteria included smoking, history of any cardiovascular disease including coronary arterial diseases, valvular heart disease, myocardial or pericardial diseases, arrhythmia, and diabetes mellitus. Also, anyone with infection or autoimmune diseases, neoplastic diseases, kidney/lung/liver diseases, major depression, and history of major surgery were excluded. The average of 3 blood pressure (BP) measurements with an interval of 5 minutes, after a rest of 10 minutes was taken from all participants. The heights and weights of all participants were recorded, and the body mass indexes (BMI) were calculated by dividing the weight into the square of the height (kg/m^2). The venous blood samples were taken from the antecubital vein of the subjects while lying in the supine position. The levels of NT-Pro BNP were measured by Cardiac Reader (Roche, Mannheim, Germany) machine. From the blood, which was taken from the radial artery with a heparin insulin injector, the COHb levels were examined with the Cobas b 221 (Roche Diagnostics Inc, Indianapolis, IN, USA) blood gas device. The PEF measurements were performed with a PEF-meter (Personel Best, Respironics New Jersey NC, USA) by asking the persons to put the device in their mouths and to blow with all their power after a deep breath while standing and after the PEF-meter needle was brought to zero. Of the 3 measurements, which were made following each other, the one with the highest value was taken. The electrocardiograph and lung-graphic of all participants were carried out and evaluated.

For all statistical analyses, the software SPSS 13.0 for Windows was used. Continuing variables, average \pm standard deviations, and exact data were shown in percents. For comparison of the variables, the student-t test, and for comparison of exact data, the chi-squared test was used. Comparison between the variables was made using the Pearson correlation test. A value of $p < 0.05$ was considered statistically meaningful.

Results. Eighty-eight people (average age 33.8 ± 7.8 years), 40 of whom were male grill-kebab chefs (average age: 33.0 ± 9.1 years) that had been working in restaurants for at least 3 years (average occupation time: 16.1 ± 7.3 years) and 48 of whom were non smoker, male healthy

Table 1 - The comparison of clinical characteristic of age, BMI, BP, COHb, NT-proBNP, and PEF percents in the control and kebab makers group

Parameters	Grill-kebab chefs	Control group	P-value
Age (year)	33.0±9.1	34.7±6.5	>0.05
BMI (kg/m ²)	24.9±4.7	25.4±6.0	>0.05
BP (mmHg)	128.3±19.3/ 81.2±16.6	124.5±13.7/ 77.3±11.3	>0.05
COHb (%)	6.5±1.5	2.0±1.1	0.001
NT-proBNP (µg/L)	48.4±9.2	44.8±6.3	>0.05
PEF (%)*	89.4±4.6	98.5±1.8	0.001

*PEF measured (L/min)/reference value (L/min) ×100. BMI - body mass indexes, BP - blood pressure, COHb - carboxy-hemoglobin, NT-proBNP - N-terminal pro brain natriuretic peptide, PEF - peak expiratory flow

Table 2- The statistical results of age, COHb, and PEF percents with Pearson correlation test in kebab makers and control groups.

Parameters	Grill-kebab chefs (N=40)		Control group (N=48)	
	P-value	r	P-value	r
Age and COHb level	0.001	0.577	0.092	0.257
COHb level and working year	0.001	0.575	-	-
COHb level and PEF percent	0.001	0.583	0.001	0.798
Working year and PEF percent	0.001	0.759	-	-
Age and PEF percent	0.001	0.622	0.460	0.109

PEF- peak expiratory flow, COHb - carboxy-hemoglobin

volunteers (average age: 34.7±6.5 years) were gathered for this study. Grill-kebab chefs and the control groups, which were integrated into the study, were compared statistically with each other regarding age, BMI, BP, COHb, NT-proBNP, and PEF percentage results as shown in Table 1. The clinical attributes, age, BMI, BP, and NT-proBNP levels of the grill-kebab chefs and the control groups were similar, however, the COHb values were significantly high at an advanced level, and the PEF percentage was statistically low at an advanced level in the grill-kebab chefs compared with the control group. There was a proportional correlation between COHb level and working years, COHb level and PEF percentage, working years and PEF percentage, and age and PEF percentage in the grill-kebab chefs (Table 2). There was an opposite proportion between working years and measured PEF values. When the working years increased, the amount of measured PEF values decreased. It was determined that the measured PEF values (average: 553.25±29.1 L/min) according to the age and height of the persons were on average 65.1 L/min lower than the reference values (average: 618.35±18.9 L/min) that were defined in Table 3.¹¹ However, in the control group, it was detected that the measured PEF values (average: 622.9±15.8 L/min) were 7.1 L/min lower than the reference values (average: 630.0±12.0 L/minute). In both groups, it was seen that the higher the COHb level was, the higher the difference between the measured PEF values and the reference PEF. The increasing level of COHb and decreasing level of PEF in grill-kebab chefs is the effect of chronic exposure to CO, as it was also noted that these effects were in a statistical meaningful correlation with age and the working years.

Table 3 - The theoretic values of PEF in adults.

Age (years)	Height(cm)						
	160	165	170	175	180	185	190
15	523	531	538	544	551	557	563
20	567	575	583	590	597	604	611
25	594	602	610	618	626	633	639
30	608	617	625	633	641	648	655
35	613	622	630	638	646	653	660
40	611	620	629	636	644	651	658
45	605	613	621	629	637	644	651
50	594	602	610	618	625	632	639
55	580	588	596	603	611	618	624
60	564	572	579	587	594	600	607
65	546	554	561	568	575	581	588
70	527	535	542	549	555	561	567
75	507	515	522	528	534	540	546
80	487	494	501	507	513	519	525
85	467	474	480	486	492	497	503

*Theoretic PEF values scale determined by Gregg and Nunn,¹² PEF- peak expiratory flow

Discussion. While there is much information regarding the effects of acute CO intoxication on the human body, information on the effects of chronic exposure to CO on the respiratory system, cardiovascular system, and atherosclerosis is limited, and the data resulting from human and animal tests do not correspond (repetition of text from introduction).^{5,13} The increase in COHb levels during CO intoxication may cause myocardial dysfunction, ischemia, infarct, arrhythmia, and cardiac arrest. There is a correlation between the intensity and prognosis of the symptoms and COHb levels.¹⁴

Chronic exposure generally occurs in smokers, traffic policemen, toll station clerks on highways, tunnel and bridge workers, workers of parking houses, machine operators, firemen, mine workers without sufficient air circulation, furnaceman, and grill-kebab chefs who are working in a closed environment without a good ventilation system. It is known that in acute CO intoxication, secondary to cardiac hazards, the NT-ProBNP values increase.¹⁵ However, there is a lack of information on the effect of chronic CO exposure and NT-ProBNP values. In our study, the results of the NT-ProBNP values both in grill-kebab chefs, who were chronically exposed to CO, and the control group was normal (<60 µg/L), and the difference between groups was not statistically significant. This suggests that chronic exposure to CO in moderation has no effect on NT-ProBNP.

There are limited studies on the effects of chronic exposure to CO and PEF values in healthy persons. It was first mentioned by Fregg and Nunn¹² that being chronically exposed to CO reduces the PEF values. In this study, the PEF values of 142 smokers were compared with theoretic normal values of healthy persons. The decrease of the PEF values in those who smoked on average less than 20 cigarettes per day was determined as 48.1 L/minute, while in those who smoked more than 20 cigarettes per day, the decrease of the PEF value was determined as 73.3 L/min. In a study by Donguk et al¹⁶ on metal melters, they determined that the PEF values of the persons who worked in those circumstances were lower than the theoretic PEF values, obtained from healthy persons. Sekine et al¹⁷ carried out a study on 5682 females in Tokyo and determined that the values of FEV1 were reduced in people living in the city and exposed to car gasses for a long time. We detected that the PEF measurements of grill-kebab chefs were on average 65.1 L/min lower than the theoretic PEF values, determined according to the age and height. In the control group, we detected that the PEF values were on average 7.1 L/min lower than the theoretic PEF values. A statistically meaningful correlation was found between working years and PEF percentage, COHb level and PEF percentage, and age and PEF percentage

in the grill-kebab chefs. However, in the control group, a statistical meaningful correlation was detected only between the COHb level and PEF percentage. The obtained results correspond with data from the literature on this issue. In our study, the PEF values of the persons chronically exposed to CO decreased according to theoretical PEF values. The decrease of PEF values of grill-kebab chefs due to their increasing number of working years shows that these persons may, later, develop pulmonary and cardiovascular diseases due to their profession. Therefore, the most important precaution to be taken regarding grill-kebab chefs is to ensure the smoke exhaust of the grills has an adequate ventilation system, and the working exposure on the grill should be reduced to the lowest level as possible. The grill-kebab chefs must undergo periodical check-ups to determine any eventual health problems, and to take precautions early.

Environment (air, CO, CO₂, and dust) in the work place of the participants was not evaluated in this study. We could not use exposure measurement, and CO was used as a surrogate. Secondly, the environmental conditions of the participants could not be controlled and because of this, their exposure to CO from air pollution, living close to motorways, passive smoking, and so forth, could not be prevented.

In conclusion, the COHb values of the grill-kebab chefs were higher than the values of the control group. The COHb values increased in persons who are working on the grill over a longer period. The more the age increased, the more the PEF values decreased. The more the working period and exposure on the grill increased, the more the PEF values decreased. Chronic exposure of CO had no effect on NT-proBNP. Higher values of COHb decreased the PEF values.

Future studies must include the effects of air, CO, and CO₂ on people constantly exposed on the grill.

References

1. Varon J, Marik PE, Fromm RE Jr, Gueler A. Carbon monoxide poisoning: a review for clinicians. *J Emerg Med* 1999; 17: 87-93.
2. Satran D, Henry CR, Adkinson C, Nicholson CI, Bracha Y, Henry TD. Cardiovascular manifestations of moderate to severe carbon monoxide poisoning. *J Am Coll Cardiol* 2005; 45: 1513-1516.
3. Neubauer RA, Neubauer V, Chi Nu AK, Maxfield WS. Treatment of Late Neurologic Sequelae of Carbon Monoxide Poisoning with Hyperbaric Oxygenation: a Case Series. *Journal of the American Physicians and Surgeons* 2006; 11: 56-59.
4. Hampson NB, Scott KL, Zmaeff JL. Carboxyhemoglobin measurement by hospitals: implications for diagnosis of carbon monoxide poisoning. *J Emerg Med* 2006; 31: 13-16.
5. Wright J. Chronic and occult carbon monoxide poisoning: we don't know what we're missing. *Emerg Med J* 2002; 19: 386-390.

6. Hamza Duygu, Uğur Türk, Mehdi Zoghi, Sanem Nalbantgil. The importance of plasma B- type natriuretic peptide levels in cardiovascular diseases. *Anadolu Kardiyol Derg* 2005; 5: 305-311.
7. Cardarelli R, Lumicao TG Jr. B-type natriuretic peptide: a review of its diagnostic, prognostic, and therapeutic monitoring value in heart failure for primary care physicians. *J Am Board Fam Pract* 2003; 16: 327-333.
8. Chiristian M, Tobias B, Kirsten L, Michael C. The integration of BNP and NT-proBNP into clinical medicine. *Swiss Med Wkly* 2007; 137: 4-12.
9. Christenson RH, Tang WH. Institute for Quality in Laboratory Medicine series--controversies in laboratory medicine: insights into B-type natriuretic peptide and N-terminal pro-B-type natriuretic peptide measurements. *MedGenMed* 2006; 8: 62.
10. Molckentin JD. A friend within the heart: natriuretic peptide receptor signaling. *J Clin Invest* 2003; 111: 1275-1277.
11. Gregg I, Nunn AJ. New regression equations for predicting peak expiratory flow in adults. *BMJ* 1989; 298: 1068-1070.
12. Gregg I, Nunn AJ. Peak expiratory flow in symptomless elderly smokers and ex-smokers. *BMJ* 1989; 298: 1071-1072.
13. Sørhaug S, Steinshamn S, Nilsen OG, Waldum HL. Chronic inhalation of carbon monoxide: Effects on the respiratory and cardiovascular system at doses corresponding to tobacco smoking. *Toxicology* 2006; 228: 280-290.
14. Raub JA, Mathieu-Nolf M, Hampson NB, Thom SR. Carbon monoxide poisoning a public health perspective. *Toxicology* 2000; 145: 1-14.
15. Davutoglu V, Gunay N, Kocoglu H, Gunay NE, Yildirim C, Cavdar M, et al. Serum levels of NT-ProBNP as an early cardiac marker of carbon monoxide poisoning. *Inhal Toxicol* 2006; 18: 155-158.
16. Park D, Chin K, Kwag H, Youn K, Choi S, Ha K, et al. Effect of metalworking fluid mist exposure on cross-shift decrement in peak expiratory flow. *J Occup Health* 2007; 49: 25-31.
17. Sekine K, Shima M, Nitta Y, Adachi A. Long term effects of exposure to automobile exhaust on the pulmonary function of female adults in Tokyo, Japan. *Occup Environ Med* 2004; 61: 350-357.

Related topics

Osarogiagbon WO, Ibadin MO, Oviawe OS. Peak expiratory flow rate variability in apparently healthy school children aged 10-15 years in Oredo, Nigeria. *Saudi Med J* 2008; 29: 1616-1620.

Ashraf M, Shaffi SA, BaHammam AS. Spirometry and flow-volume curve in patients with obstructive sleep apnea. *Saudi Med J* 2008; 29: 198-202.

Meo SA, Al-Drees AM, Arif M, Al-Rubean K. Lung function in type 2 Saudi diabetic patients. *Saudi Med J* 2006; 27: 338-343.

Meo SA, Al-Drees AM, Shah SF, Arif M, Al-Rubean K. Lung function in type 1 Saudi diabetic patients. *Saudi Med J* 2005; 26: 1728-1733.

Alamoudi OS. Pitfalls of inhalation technique in chronic asthmatics. Effect of education program and correlation with peak expiratory flow. *Saudi Med J* 2003; 24: 1205-1209.

Meo SA, Al-Khlaiwi T. Health hazards of welding fumes. *Saudi Med J* 2003; 24: 1176-1182.